Fig.1A

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Fig.1B

```
                    ┌──────────────────┐
                    │   Application    │
                    │       or         │──── 40
                    │  Extender task   │
                    └──────────────────┘
                             │
                             ▼
                    ┌──────────────────┐
                    │   Input-Output   │
                    │     Manager      │──── 42
                    │                  │
                    └──────────────────┘
                             │
                             ▼
                    ┌──────────────────┐
                    │  File Redirector │
                    │      driver      │──── 44
                    │                  │
                    └──────────────────┘
              ┌──────────────┴──────────────┐
              ▼                              ▼
    ┌─────────────────────┐        ┌─────────────────────┐
    │ Primary             │        │ Secondary           │
    │ storage             │        │ storage             │
    │  ┌───────────────┐  │        │  ┌───────────────┐  │
    │  │  File System  │──┼── 46   │  │  File System  │──┼── 48
    │  └───────────────┘  │        │  └───────────────┘  │
    │         │           │        │         │           │
    │         ▼           │        │         ▼           │
    │  ┌───────────────┐  │        │  ┌───────────────┐  │
    │  │Storage Device │──┼── 50   │  │Storage Device │──┼── 52
    │  └───────────────┘  │        │  └───────────────┘  │
    │         │           │        │         │           │
    │         ▼           │        │         ▼           │
    │  ┌───────────────┐  │        │  ┌───────────────┐  │
    │  │Storage device │──┼── 54   │  │Storage device │──┼── 56
    │  └───────────────┘  │        │  └───────────────┘  │
    └─────────────────────┘        └─────────────────────┘
```
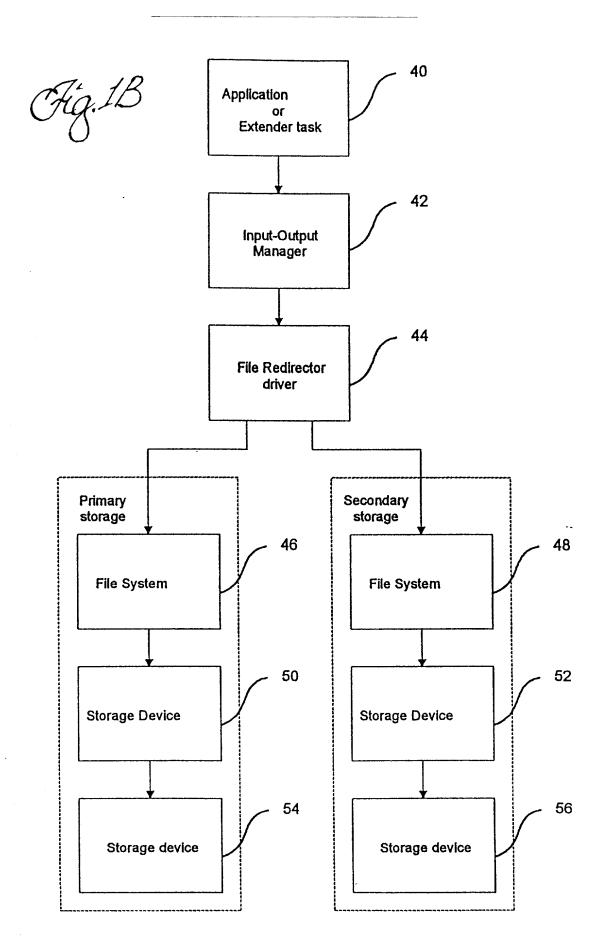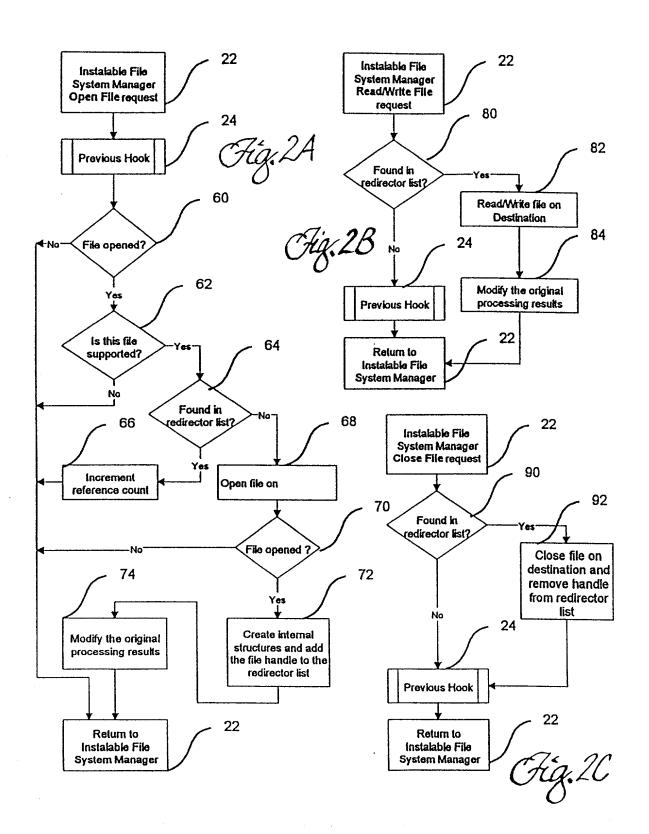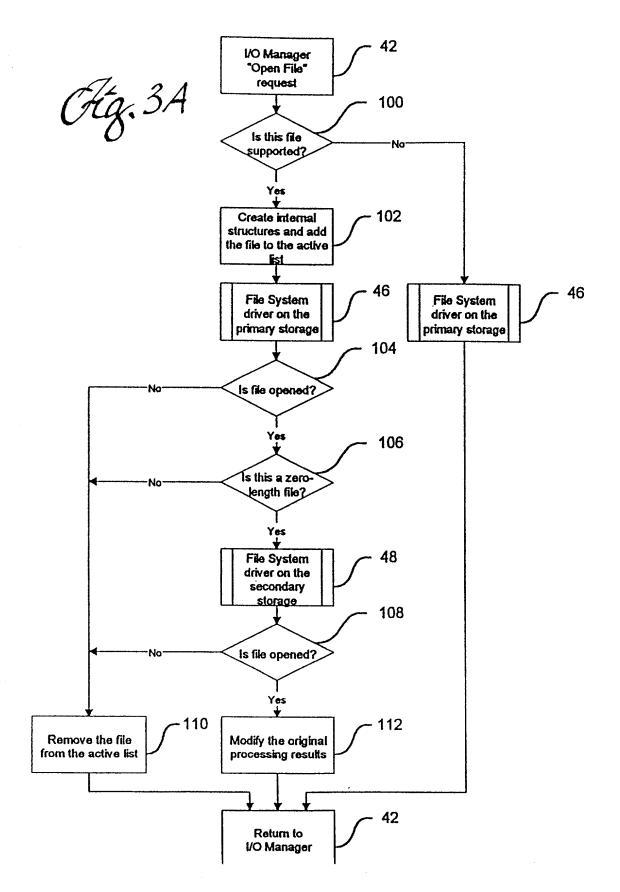
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Fig. 2A

- Installable File System Manager Open File request — 22
- Previous Hook — 24
- File opened? — 60
  - No →
  - Yes ↓
- Is this file supported? — 62
  - No →
  - Yes →
- Found in redirector list? — 64
  - Yes → Increment reference count — 66
  - No → Open file on — 68
- File opened? — 70
  - No →
  - Yes ↓
- Create internal structures and add the file handle to the redirector list — 72
- Modify the original processing results — 74
- Return to Installable File System Manager — 22

Fig. 2B

- Installable File System Manager Read/Write File request — 22
- Found in redirector list? — 80
  - Yes → Read/Write file on Destination — 82 → Modify the original processing results — 84
  - No ↓
- Previous Hook — 24
- Return to Installable File System Manager — 22

Fig. 2C

- Installable File System Manager Close File request — 22
- Found in redirector list? — 90
  - Yes → Close file on destination and remove handle from redirector list — 92
  - No ↓
- Previous Hook — 24
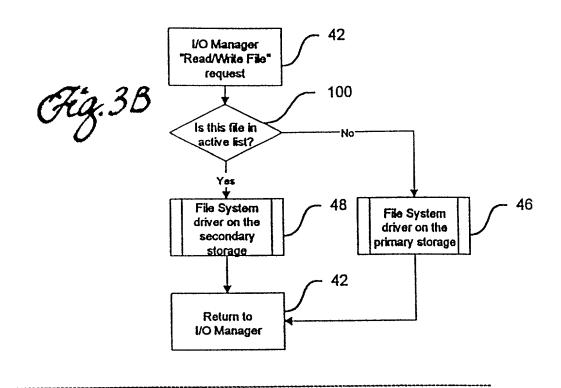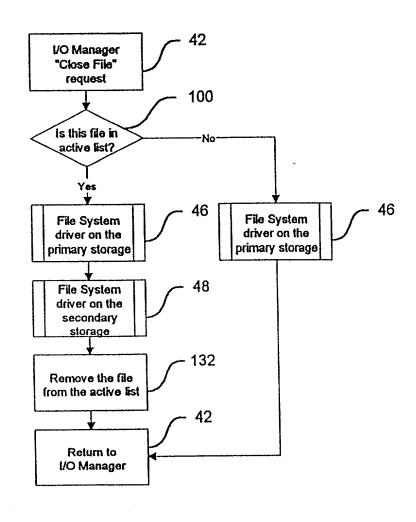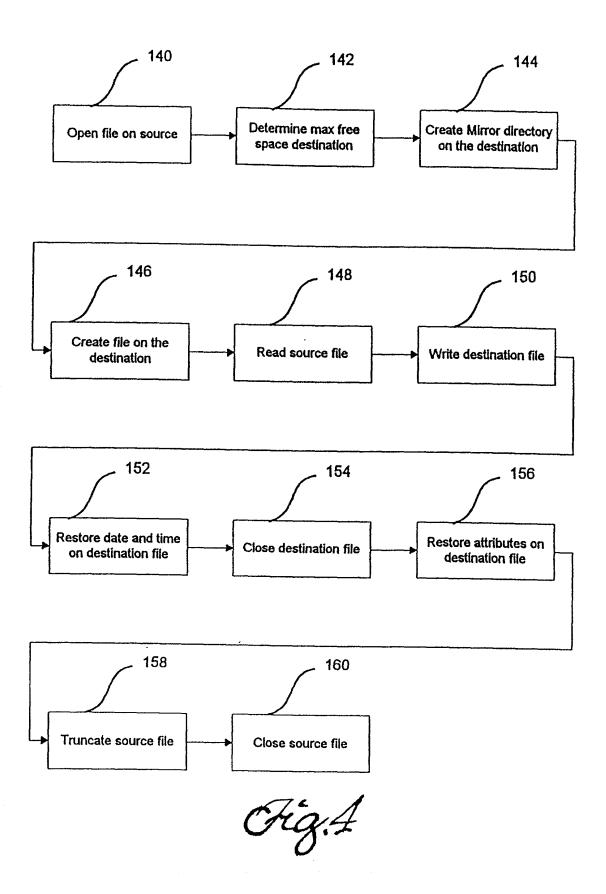- Return to Installable File System Manager — 22

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Fig. 3A

```
                    ┌─────────────────┐
                    │  I/O Manager    │── 42
                    │  "Open File"    │
                    │   request       │
                    └─────────────────┘
                            │
                            ▼
                         ╱─────────╲
                        ╱  Is this  ╲────── No ──────────────────┐
                        ╲   file     ╱ 100                        │
                         ╲supported?╱                            │
                          ╲───────╱                              │
                             │                                   │
                            Yes                                  │
                             ▼                                   │
                    ┌─────────────────┐                         │
                    │ Create internal │── 102                   │
                    │ structures and  │                         │
                    │ add the file to │                         │
                    │ the active list │                         │
                    └─────────────────┘                         │
                             │                                   │
                             ▼                                   ▼
                    ┌─────────────────┐              ┌─────────────────┐
                    │  File System    │── 46         │  File System    │── 46
                    │  driver on the  │              │  driver on the  │
                    │ primary storage │              │ primary storage │
                    └─────────────────┘              └─────────────────┘
                             │
                             ▼
                         ╱─────────╲
          ┌──── No ─────╱ Is file   ╲ 104
          │             ╲  opened?   ╱
          │              ╲─────────╱
          │                 │
          │                Yes
          │                 ▼
          │             ╱─────────╲
          │◄─── No ────╱ Is this a  ╲ 106
          │            ╲ zero-length ╱
          │             ╲  file?    ╱
          │              ╲───────╱
          │                 │
          │                Yes
          │                 ▼
          │        ┌─────────────────┐
          │        │  File System    │── 48
          │        │  driver on the  │
          │        │   secondary     │
          │        │    storage      │
          │        └─────────────────┘
          │                 │
          │                 ▼
          │             ╱─────────╲
          │◄─── No ────╱ Is file   ╲ 108
          │            ╲  opened?   ╱
          │             ╲─────────╱
          │                 │
          │                Yes
          ▼                 ▼
  ┌─────────────────┐  ┌─────────────────┐
  │ Remove the file │  │ Modify the      │
  │ from the active │  │ original        │
  │     list        │  │ processing      │
  │           110   │  │ results    112  │
  └─────────────────┘  └─────────────────┘
          │                 │                      │
          └────────┬────────┴──────────────────────┘
                   ▼
          ┌─────────────────┐
          │   Return to     │── 42
          │   I/O Manager   │
          └─────────────────┘
```

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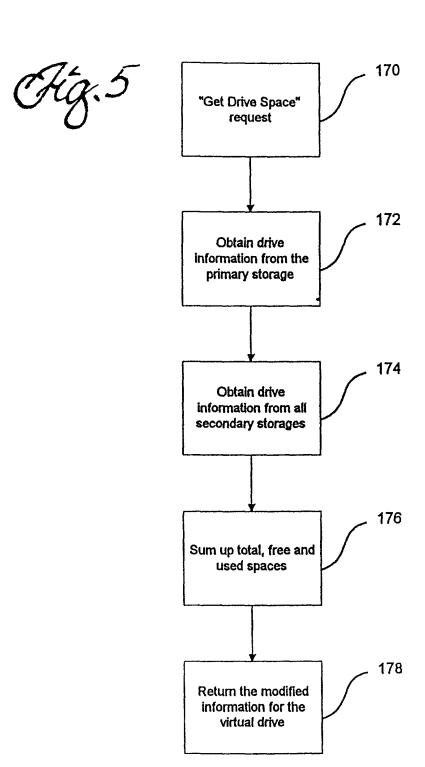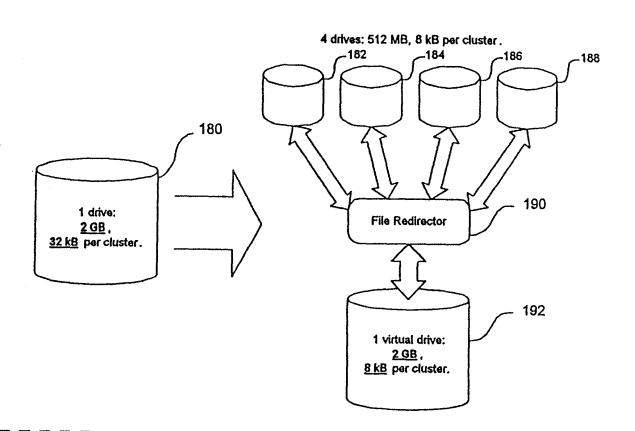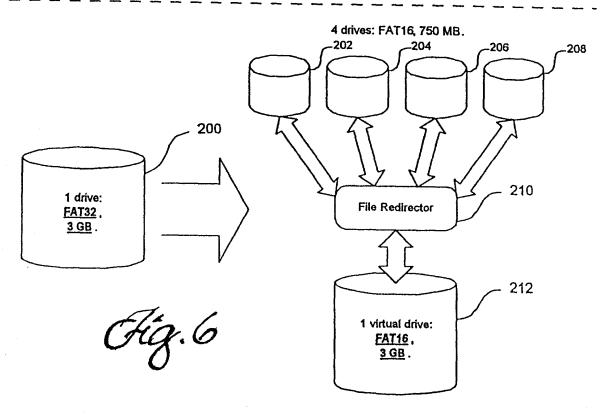ELECTRONIC DATA STORAGE MANAGEMENT
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Fig.3B

```
┌─────────────────┐
│   I/O Manager   │ ⟋ 42
│ "Read/Write File"│
│     request     │
└─────────────────┘
         │
         ▼
    ◇─────────◇ ⟋ 100
   ╱ Is this file ╲      No
   ╲  in active    ╱ ──────────────┐
    ╲   list?    ╱                  │
      ◇───────◇                     │
         │                          │
        Yes                         ▼
         ▼                   ┌──────────────┐
┌─────────────────┐ ⟋ 48    │  File System │ ⟋ 46
│   File System   │         │ driver on the│
│  driver on the  │         │primary storage│
│    secondary    │         └──────────────┘
│     storage     │                  │
└─────────────────┘                  │
         │                           │
         ▼                           │
┌─────────────────┐ ⟋ 42             │
│   Return to     │◄─────────────────┘
│  I/O Manager    │
└─────────────────┘
```

- -

```
┌─────────────────┐
│   I/O Manager   │ ⟋ 42
│  "Close File"   │
│     request     │
└─────────────────┘
         │
         ▼
    ◇─────────◇ ⟋ 100
   ╱ Is this file ╲      No
   ╲  in active    ╱ ──────────────┐
    ╲   list?    ╱                  │
      ◇───────◇                     │
         │                          │
        Yes                         ▼
         ▼                   ┌──────────────┐
┌─────────────────┐ ⟋ 46    │  File System │ ⟋ 46
│   File System   │         │ driver on the│
│  driver on the  │         │primary storage│
│ primary storage │         └──────────────┘
└─────────────────┘                  │
         │                           │
         ▼                           │
┌─────────────────┐ ⟋ 48             │
│   File System   │                  │
│  driver on the  │                  │
│    secondary    │                  │
│     storage     │                  │
└─────────────────┘                  │
         │                           │
         ▼                           │
┌─────────────────┐ ⟋ 132            │
│  Remove the file│                  │
│ from the active │                  │
│      list       │                  │
└─────────────────┘                  │
         │                           │
         ▼                  ⟋ 42     │
┌─────────────────┐                  │
│   Return to     │◄─────────────────┘
│  I/O Manager    │
└─────────────────┘
```
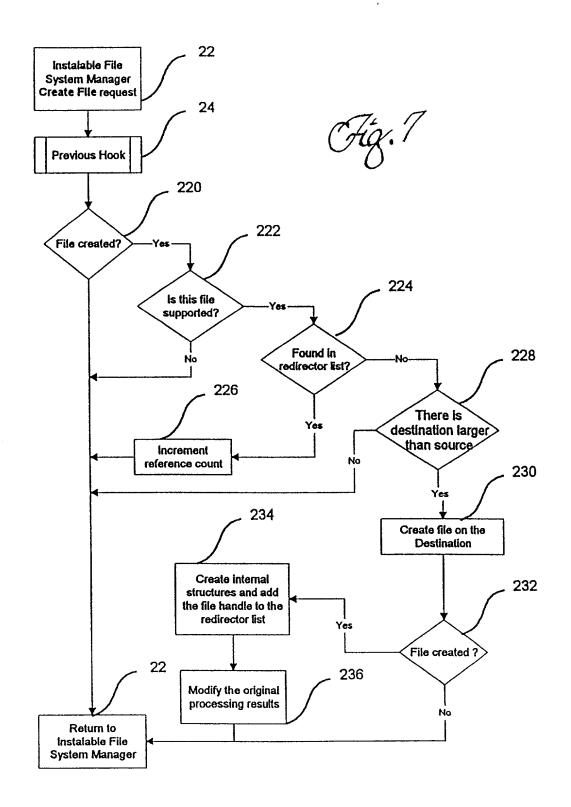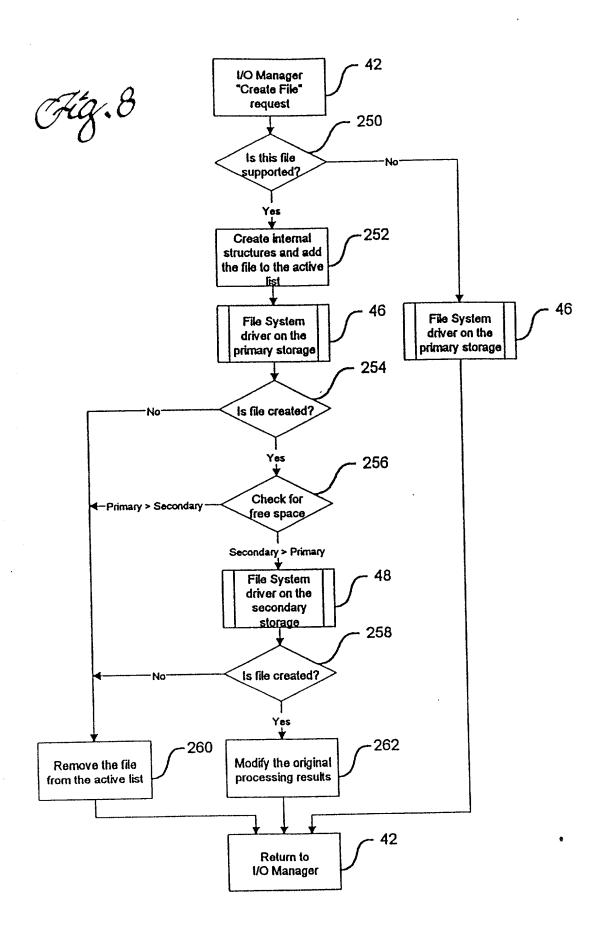
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140

Open file on source

142

Determine max free
space destination

144

Create Mirror directory
on the destination

146

Create file on the
destination

148

Read source file

150

Write destination file

152

Restore date and time
on destination file

154

Close destination file

156

Restore attributes on
destination file

158

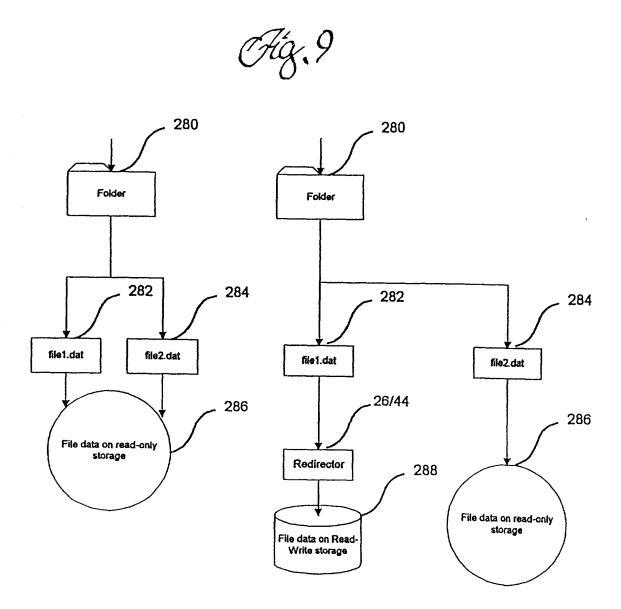Truncate source file

160

Close source file

Fig.4

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Fig.5

"Get Drive Space" request — 170

Obtain drive information from the primary storage — 172

Obtain drive information from all secondary storages — 174

Sum up total, free and used spaces — 176

Return the modified information for the virtual drive — 178

4 drives: 512 MB, 8 kB per cluster.

182   184   186   188

180

1 drive:
2 GB,
32 kB per cluster.

File Redirector

190

192

1 virtual drive:
2 GB,
8 kB per cluster.

4 drives: FAT16, 750 MB.

202   204   206   208

200

1 drive:
FAT32,
3 GB.

File Redirector

210

212

1 virtual drive:
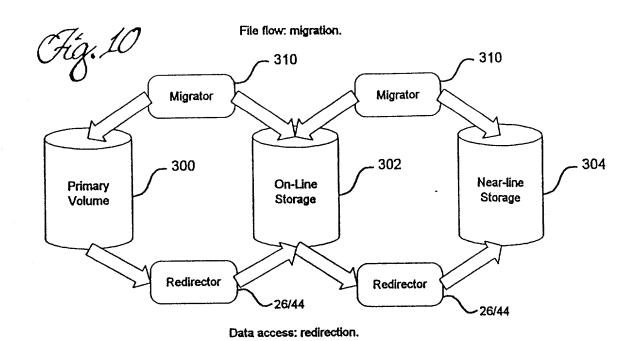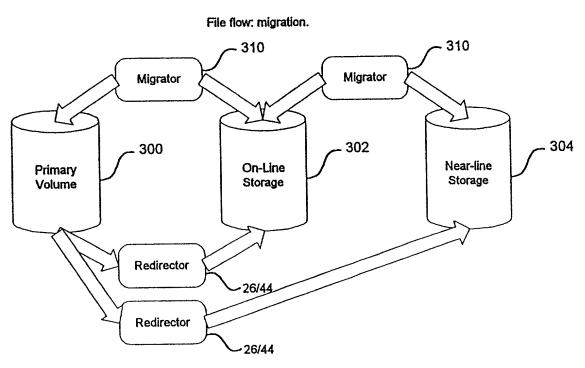**FAT16**,
3 GB.

Fig. 6

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Fig. 7

```
┌─────────────────────┐
│ Instalable File      │  22
│ System Manager       │
│ Create File request  │
└─────────────────────┘
          │
          ▼
┌─────────────────────┐  24
│   Previous Hook      │
└─────────────────────┘
          │
          ▼
     ◇ File created? ◇───Yes──┐  220
          │                   │
          │No                 ▼
          │              ◇ Is this file ◇───Yes───┐  222
          │                supported?             │
          │                   │                   ▼
          │                   No              ◇ Found in ◇───No───┐  224
          │                   │                redirector list?    │
          │                   │                   │               ▼
          │                   │                   Yes        ◇ There is ◇  228
          │                   │                   │           destination larger
          │                   │                   │           than source
          │              ┌──────────────┐         │               │
          │              │  Increment    │◀────────┘               Yes
          │              │ reference count│                        │  230
          │              └──────────────┘                          ▼
          │                   │                            ┌──────────────┐
          │◀──────────────────┘                            │ Create file on the│
          │                                        No ◀─────│   Destination     │
          │                                                 └──────────────┘
          │         ┌──────────────────┐                           │  232
          │         │ Create internal   │  234                      ▼
          │         │ structures and add │◀───Yes───────    ◇ File created ? ◇
          │         │ the file handle to │                          │
          │         │ the redirector list│                          No
          │         └──────────────────┘                            │
          │                   │                                      │
┌──────────────────┐  22      ▼                                      │
│ Return to         │   ┌──────────────────┐  236                    │
│ Instalable File   │◀──│ Modify the original│◀─────────────────────┘
│ System Manager    │   │ processing results │
└──────────────────┘   └──────────────────┘
```

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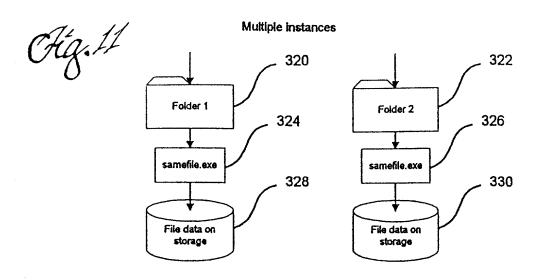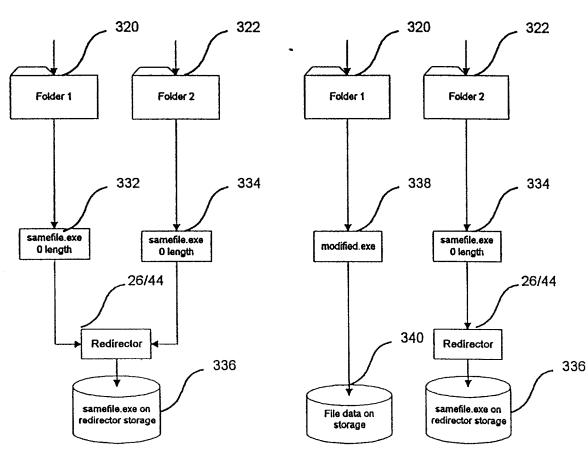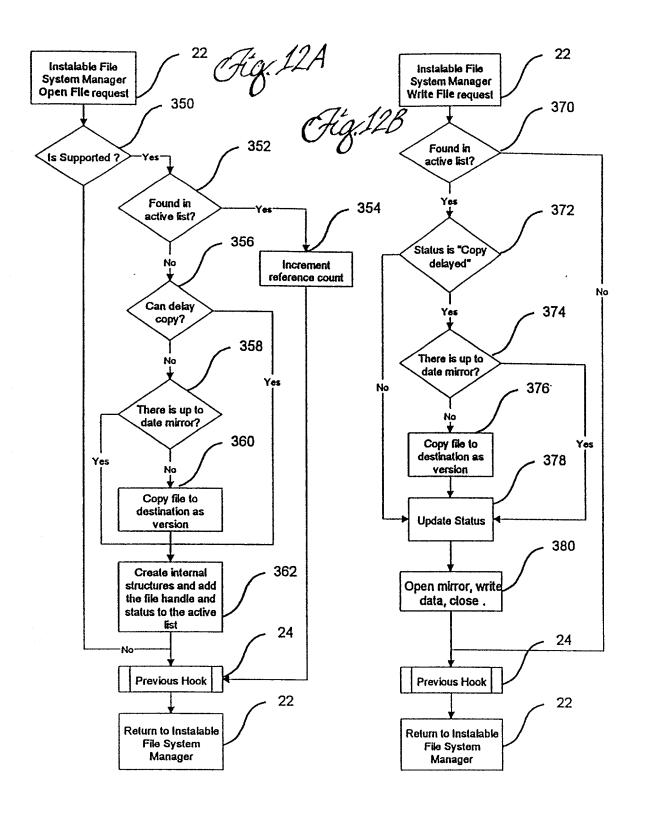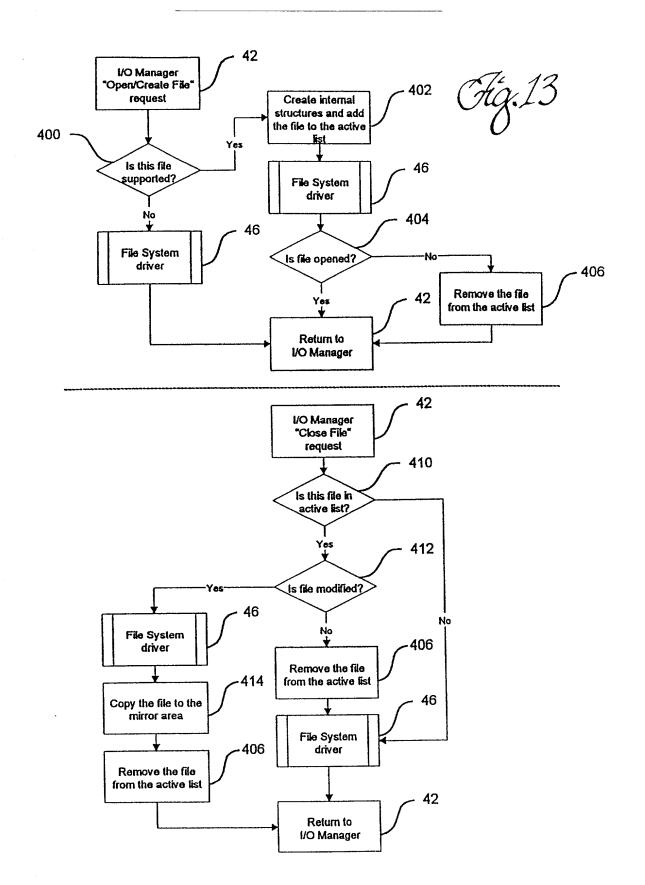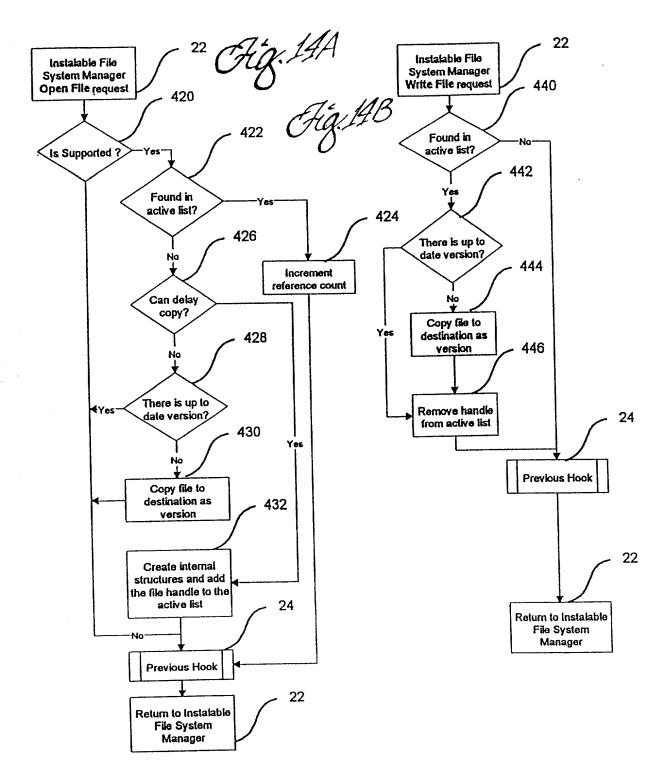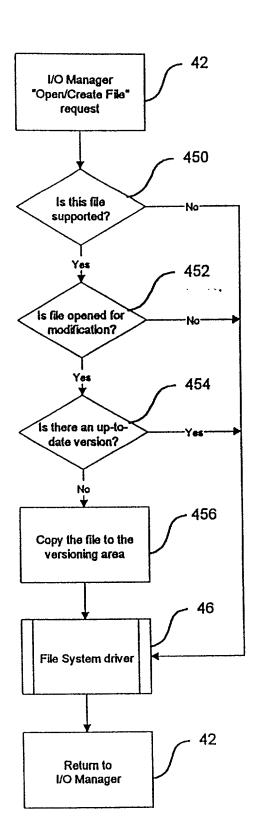ELECTRONIC DATA STORAGE MANAGEMENT
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Fig.8

```
                    ┌──────────────────┐
                    │   I/O Manager    │── 42
                    │  "Create File"   │
                    │     request      │
                    └──────────────────┘
                             │
                             ▼
                    ╱─────────────────╲              250
                   ╱   Is this file    ╲───── No ─────────────────┐
                   ╲    supported?     ╱                          │
                    ╲─────────────────╱                           │
                             │                                    │
                            Yes                                   │
                             ▼                                    │
                    ┌──────────────────┐                          │
                    │ Create internal  │── 252                    │
                    │structures and add│                          │
                    │the file to the active│                      │
                    │       list       │                          │
                    └──────────────────┘                          │
                             │                                    │
                             ▼                                    ▼
                    ┌──────────────────┐            ┌──────────────────┐
                    │   File System    │── 46       │   File System    │── 46
                    │  driver on the   │            │  driver on the   │
                    │ primary storage  │            │ primary storage  │
                    └──────────────────┘            └──────────────────┘
                             │                                    │
                             ▼             254                    │
                    ╱─────────────────╲                           │
      ┌──── No ────╱   Is file created? ╲                         │
      │            ╲                   ╱                          │
      │             ╲─────────────────╱                           │
      │                      │                                    │
      │                     Yes                                   │
      │                      ▼             256                    │
      │             ╱─────────────────╲                           │
      │  Primary >  ╱   Check for      ╲                          │
      ├─ Secondary ─╱    free space    ╲                          │
      │             ╲─────────────────╱                           │
      │                      │                                    │
      │            Secondary > Primary                            │
      │                      ▼                                    │
      │             ┌──────────────────┐                          │
      │             │   File System    │── 48                     │
      │             │  driver on the   │                          │
      │             │    secondary     │                          │
      │             │     storage      │                          │
      │             └──────────────────┘                          │
      │                      │             258                    │
      │             ╱─────────────────╲                           │
      ├──── No ────╱   Is file created? ╲                         │
      │             ╲                   ╱                         │
      │              ╲─────────────────╱                          │
      │                      │                                    │
      │                     Yes                                   │
      ▼                      ▼                                    │
┌──────────────┐    ┌──────────────────┐                         │
│Remove the file│─260│Modify the original│─262                   │
│from the active│   │ processing results│                        │
│     list     │    └──────────────────┘                         │
└──────────────┘            │                                    │
      │                     │                                    │
      └──────────┬──────────┴────────────────────────────────────┘
                 ▼
        ┌──────────────────┐
        │   Return to      │── 42
        │   I/O Manager    │
        └──────────────────┘
```

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Fig. 9

280

Folder

282   284

file1.dat   **file2.dat**

286

File data on read-only
storage

280

Folder

282   284

file1.dat   **file2.dat**

26/44

Redirector   286

288

File data on Read-
Write storage
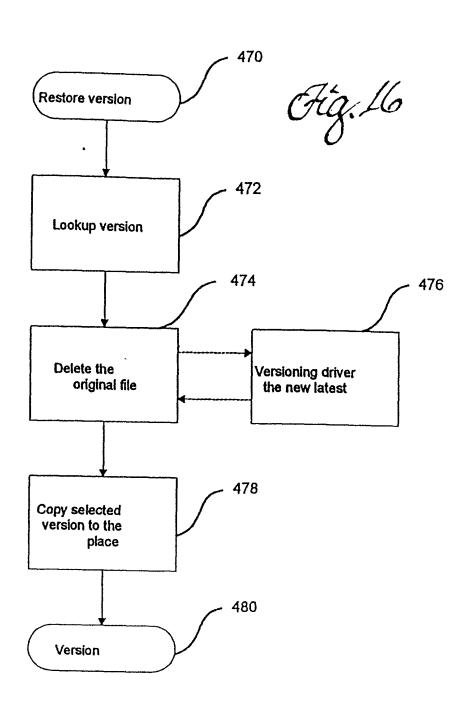
File data on read-only
storage

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Fig. 10

File flow: migration.

Data access: redirection.

File flow: migration.

Data access: redirection.

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Fig.11

Multiple instances

Folder 1 — 320

samefile.exe — 324

File data on storage — 328

Folder 2 — 322

samefile.exe — 326

File data on storage — 330

Single instance , read only access

Folder 1 — 320

Folder 2 — 322

samefile.exe 0 length — 332

samefile.exe 0 length — 334

Redirector — 26/44

samefile.exe on redirector storage — 336

Read/Write access

Folder 1 — 320

Folder 2 — 322

modified.exe — 338

samefile.exe 0 length — 334

File data on storage — 340

Redirector — 26/44

samefile.exe on redirector storage — 336

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Fig.12A

Fig.12B

Fig. 12A (left flowchart):

22 — Instalable File System Manager Open File request

350 — Is Supported ?

— No → Previous Hook (24)

— Yes →

352 — Found in active list?

— Yes → 354 Increment reference count

— No →

356 — Can delay copy?

— Yes →

— No →

358 — There is up to date mirror?

— Yes →

— No →

360 — Copy file to destination as version

362 — Create internal structures and add the file handle and status to the active list

24 — Previous Hook

22 — Return to Instalable File System Manager

Fig. 12B (right flowchart):

22 — Instalable File System Manager Write File request

370 — Found in active list?

— Yes →

— No →

372 — Status is "Copy delayed"

— Yes →

— No →

374 — There is up to date mirror?

— Yes →

— No →

376 — Copy file to destination as version

378 — Update Status

380 — Open mirror, write data, close .

24 — Previous Hook

22 — Return to Instalable File System Manager

Fig.13

I/O Manager "Open/Create File" request — 42

Is this file supported? — 400

Yes → Create internal structures and add the file to the active list — 402

File System driver — 46

No → File System driver — 46

Is file opened? — 404

No → Remove the file from the active list — 406

Yes → Return to I/O Manager — 42

I/O Manager "Close File" request — 42

Is this file in active list? — 410

Yes → Is file modified? — 412

No (410 path)

Yes → File System driver — 46

Copy the file to the mirror area — 414

Remove the file from the active list — 406

No (412) → Remove the file from the active list — 406

File System driver — 46

Return to I/O Manager — 42

Fig.14A

Fig.14B

22

Instalable File System Manager Open File request

420

Is Supported ? — Yes

422

Found in active list? — Yes

424

Increment reference count

426

No

Can delay copy?

No

428

There is up to date version? — Yes

430

No

Copy file to destination as version

432

Create internal structures and add the file handle to the active list — No

24

Previous Hook

22

Return to Instalable File System Manager

22

Instalable File System Manager Write File request

440

Found in active list? — No

442

Yes

There is up to date version?

444

No

Copy file to destination as version

Yes

446

Remove handle from active list

24

Previous Hook

22

Return to Instalable File System Manager

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Fig. 15

I/O Manager
"Open/Create File"
request — 42

↓

Is this file
supported? — 450 —No→

Yes ↓

Is file opened for
modification? — 452 —No→

Yes ↓

Is there an up-to-
date version? — 454 —Yes→

No ↓

Copy the file to the
versioning area — 456

↓

File System driver — 46

↓

Return to
I/O Manager — 42

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470

Restore version

Fig.16

472

Lookup version

474

Delete the
original file

476

Versioning driver
the new latest

478

Copy selected
version to the
place

480

Version

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Fig. 17

Left flowchart:

Instalable File System Manager Open File request — 22

Found in redirection table?

No →

Yes ↓

Store input path and volume handle

Change input path and volume handle — 500

Previous Hook — 502

Restore input path and volume handle — 504

File opened? — No →

Yes ↓

Found in redirector list? — Yes →

No ↓

Create internal structures and add the file handle and volume handle to the redirector list

Increment reference count

Return to Instalable File System Manager — 22

Right flowchart:

Instalable File System Manager Read/Write/Close File request — 22

Found in redirector list?

No →

Yes ↓

Store input volume handle

Change input volume handle — 506

Previous Hook — 502

Restore input volume handle — 508

Close? — No →

Yes ↓

Decrement reference count

Reference count is 0? — Yes →

No ↓

Remove handle from redirector list

Return to Instalable File System Manager — 22

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Fig. 18

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Figure 19